The new Oxford planetary unified model system for Venus (OPUS-V)

Conference or Workshop Item

THE NEW OXFORD PLANETARY UNIFIED MODEL SYSTEM FOR VENUS (OPUS-V). João M. Mendonça[1], Peter L. Read[1], Stephen R. Lewis[2], and Christopher Lee[3]
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Introduction: Venus models are at the stage of evolving from simplified General Circulation Models (SGCM) towards more complete and physically-based ones ([1], [2] and [3]). The process is complex and challenging due to difficulties in reproducing the physical and dynamical conditions of the global atmosphere of Venus in a realistic numerical approach. The Venus atmospheric circulation is well known to exhibit strong super-rotation and a variety of enigmatic features which remain poorly understood.

Here we present a new version of the Oxford Planetary Unified (Model) System for Venus (OPUS-V). This model is the expansion and improvement of an existing simplified version ([1]) which uses as basis a dynamical core from an Earth GCM called HadCM3 ([4]). New pameterisations were developed and implemented, being more suitable to simulate the extreme Venus climate, such as: a complex radiation scheme for solar and thermal spectral regions ([3]), a new convection scheme, a realistic boundary layer and a dynamical core that takes into account the dependence of the heat capacity with temperature.

Simulated Atmospheric Circulation: The model presented here produces a realistic Venus mesosphere atmospheric circulation. This result is an important improvement over earlier simplified General Circulation Models, and an essential tool to explore the atmospheric circulation, which will consequently advance the interpretation of the observational data. We present the zonal wind maps and the important climatic diagnostics, which help us to have a better understanding of the mechanisms for the formation of the atmospheric super-rotation. We also present results showing good agreement between the simulated global zonal winds and the ones constrained by the observations ([5]).

The magnitude of the mesosphere winds at the equilibrium state, where the total angular of the atmosphere evolve roughly constant with time, depends on the different intensities of the initial zonal wind fields. Currently, three different regimes have been obtained and are presented here. Starting with a rest atmosphere or a super-rotation obtained by the simplified version, the current model produces mesospheric zonal winds in agreement with the observations. The other two states show a global super-rotation of the atmosphere even stronger than the one observed, being one of them in the retrograde direction. To obtain these two statistic equilibrium states, the model is started with an absolute super-rotation four times larger than the one obtained by the simplified version: in the prograde direction for a prograde super-rotation or in the retrograde direction for a retrograde super-rotation.

The model's results suggest two main different mechanisms for the formation of the strong prograde winds, which act in two different regions of the Venus atmosphere: upper atmosphere (60-100km) and lower atmosphere (0-60 km). A consistent theory for the general super-rotation is proposed and discussed. Its implications are also discussed for other terrestrial atmospheres: Earth, Mars and Titan.

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